



Light Pollution



Royal Astronomical Society of Canada
Sunshine Coast Centre

www.coastastronomy.ca

MJB, 2014

Northridge, CA, 1994



What is it?



Our galaxy: The Milky Way



Light Pollution



Light Pollution

- ▶ **Light pollution** is the wasteful and obtrusive emission of artificial light by humans
 - it can have disastrous consequences for the affected local environments
 - it disrupts animal populations
 - it affects human health
 - it wastes energy, and ultimately
 - It degrades urban living
 - it blocks the night sky from astronomers and hopeful stargazers!

Our affluent society by night



Our affluent society by night



A waste of energy and a disregard
of the natural night

The basic problem: Sky Glow

- ▶ Light from fixtures reflects off particles in the sky creating "Sky Glow".
- ▶ Large cities are visible from tens of miles.
- ▶ The stars are not brighter in the country - the sky is actually *darker*!



A related problem: Glare

- ▶ Light directly seen from fixtures is called "glare"
- ▶ Headlights are a familiar example.



More light – less visibility



More light on one property means
less visibility over a wide area

Roadway lighting-overhead glare



Effective roadway lighting



Full cut off lighting improves visibility over a critical area while limiting the impact on the surrounding countryside (Hwy 416, Ottawa)

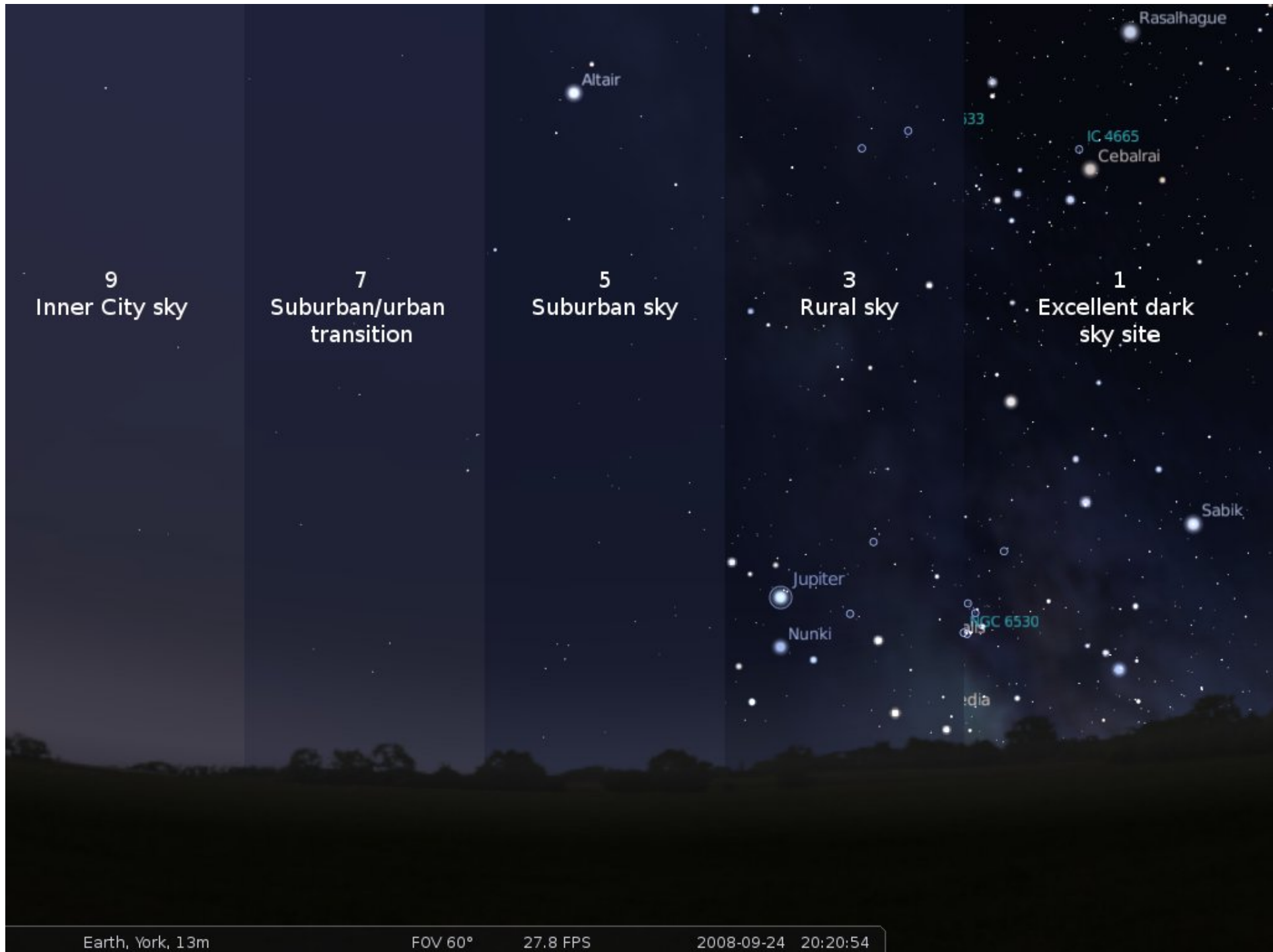
Light Trespass

- ▶ Light trespass occurs when unwanted light enters one's property
 - for instance by shining over a neighbour's fence.
 - common light trespass problem occurs when a strong light enters the window of one's home from the outside, causing problems such as sleep deprivation or the blocking of an evening view.

Light trespass



The bedrooms of these homes are never dark.



9
Inner City sky

7
Suburban/urban
transition

5
Suburban sky

3
Rural sky

1
Excellent dark
sky site

Altair

Rasalhague

IC 33

IC 4665

Cebalrai

Sabik

Jupiter

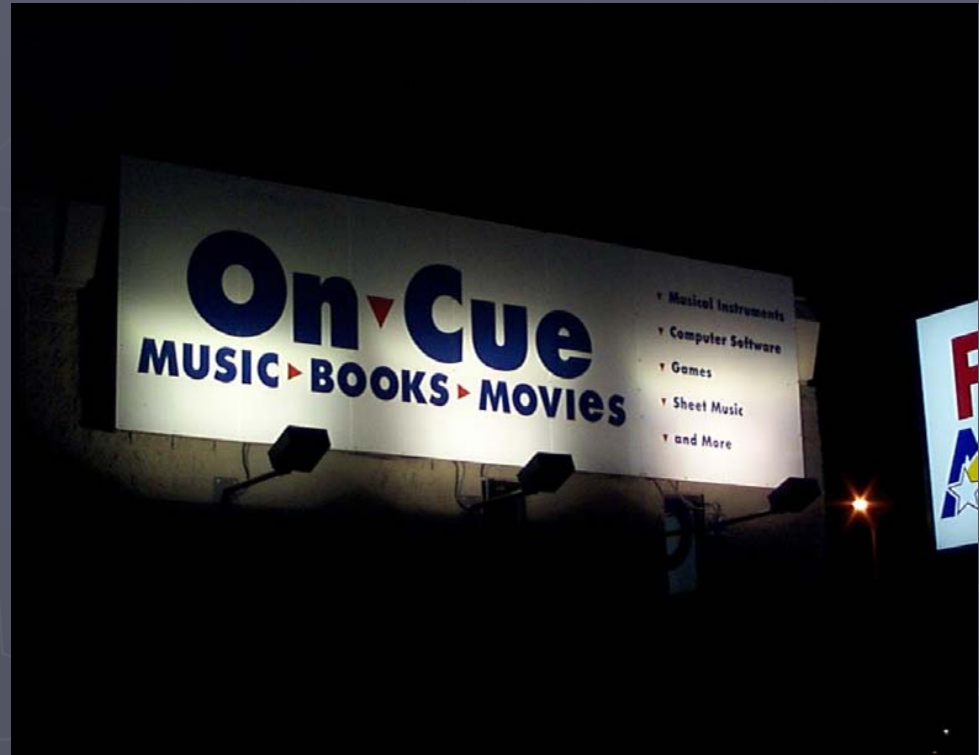
Nunki

NGC 6530

dila

Billboards: the Bad Way

- ▶ Uplighting
- ▶ Most light reflected into the sky and wasted
- ▶ Often on all night



Excessive illumination can be dangerous

- ▶ This level of illumination can be quite dangerous – you are night-blind for several minutes after leaving
- ▶ Drivers may leave headlights off.
- ▶ Danger to drivers passing by.



Compare to This

- ▶ It can be done well and it saves energy!

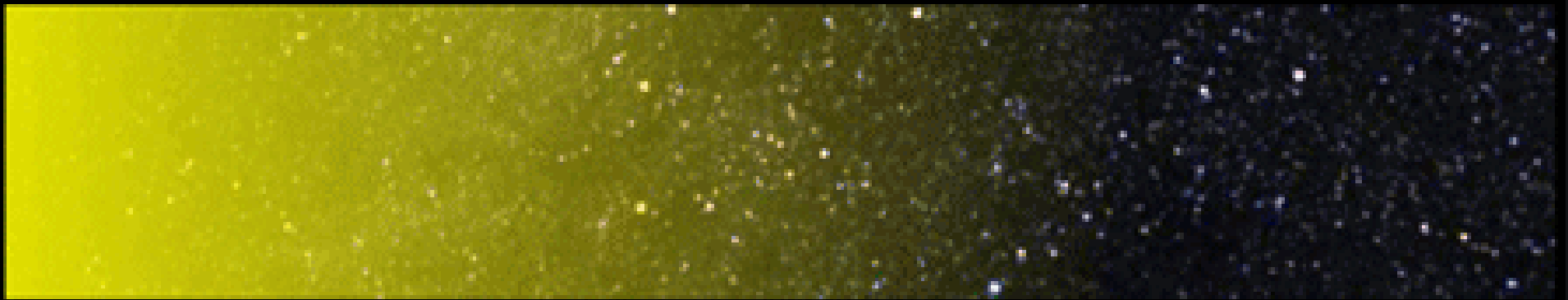


Floodlight used for “security”

- ▶ Glare! Could you actually see a criminal? ...
- ▶ But he can see you...



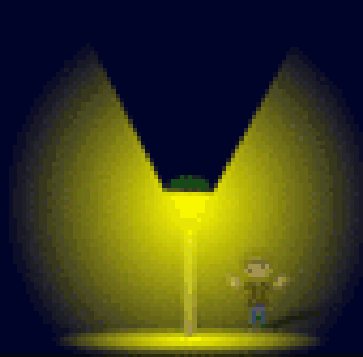
Lighting Design



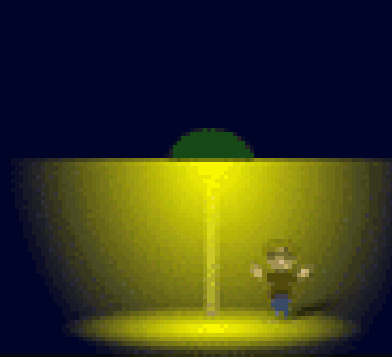
very bad



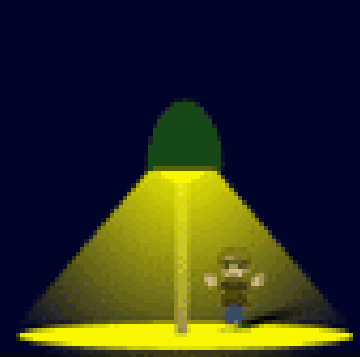
bad



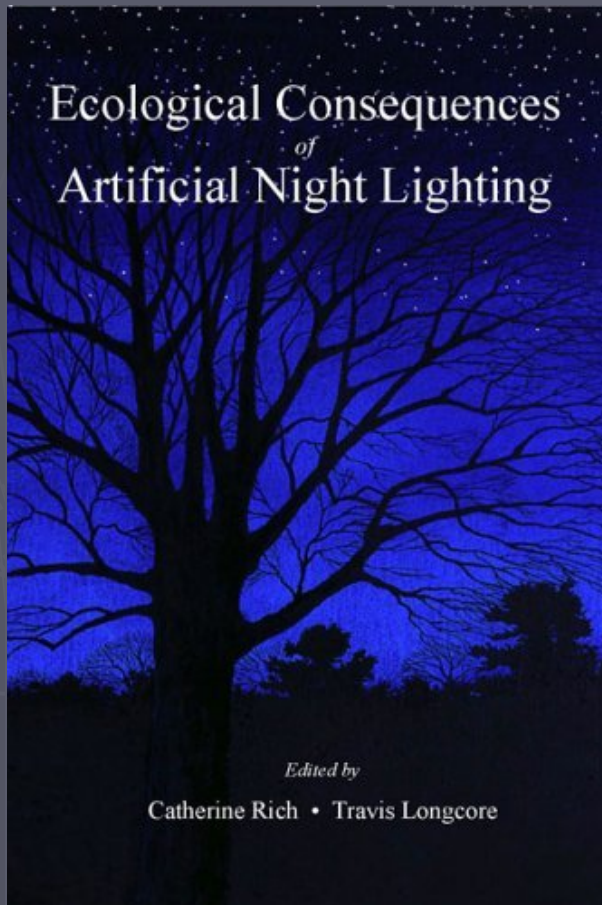
better



best



Effect of Light Pollution on Plants and Animals



- ▶ It disrupts ecology of plants and animals (including humans) that require a nightly quota of darkness
- ▶ It may interfere with mating activity among nocturnal species
- ▶ It can delay nightly feeding excursions of nocturnal animals
- ▶ Strong lights attract certain insects away from darker areas hunted by nocturnal insectivores.
- ▶ Migrating birds navigating by starlight can be led astray by lights, crashing into lit towers/buildings or circling until they become exhausted

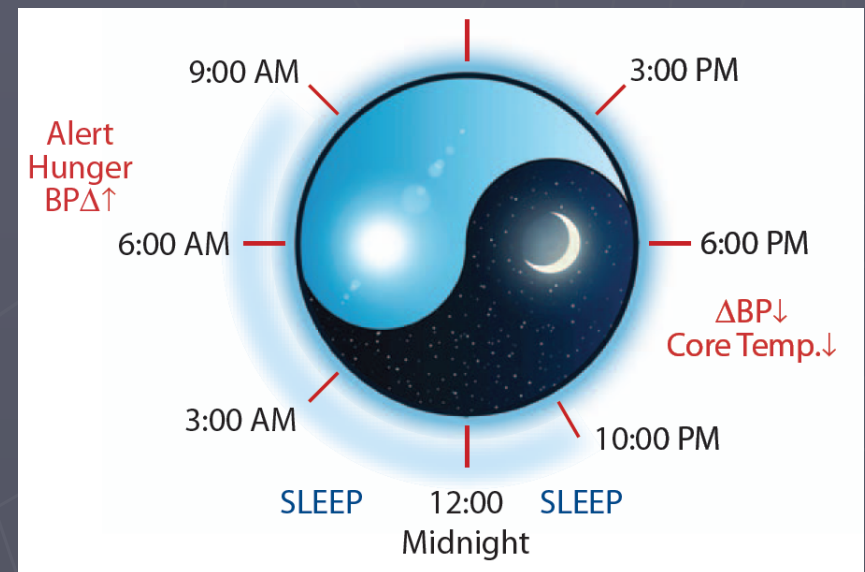
Effect of Light Pollution on Humans

- ▶ Like most animals, humans need darkness.

It is essential to our biological welfare.

Our waking and sleeping cycles, one of our circadian rhythms, is the biological expression of the regular oscillation between light and dark.

The World Health Organisation now lists disruption of circadian rhythm as a probable human carcinogen



EXPEDITION WEEK BEGINS NOVEMBER 16 ON NATIONAL GEOGRAPHIC CHANNEL

NATIONAL
GEOGRAPHIC

THE END OF
NIGHT

Why We Need Darkness

Harvest's Maelstrom of Light • Colors of Crystal Islands
Tillamook's A People's Story • England's Last Kingdom
Canadian Map Makers

Thank You!

•Source: National Geographic, November 2008

Spare Slides

The background of the slide is a dark blue-grey color. In the lower-left corner, there is a faint, light-grey graphic of a compass rose with a needle pointing towards the top-left. The compass rose has letters 'N', 'E', 'S', and 'W' and some numbers. To the right and extending across the bottom of the slide is a faint, light-grey topographic map with irregular contour lines.

Mont-Megantic (PQ)



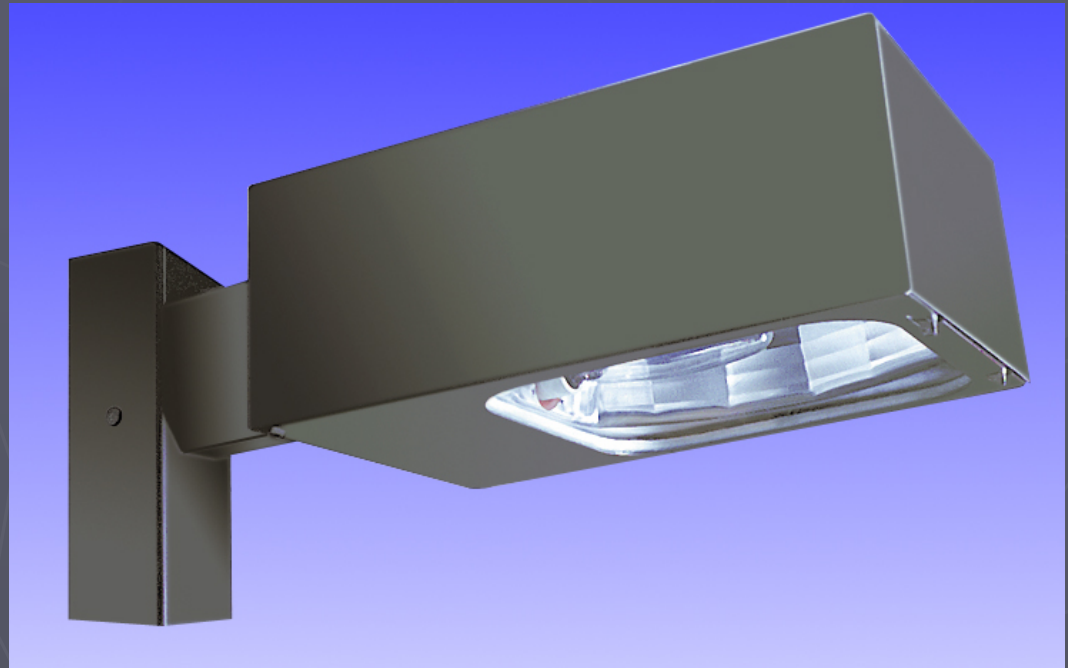
The Milky way
above

Light pollution on
the horizon

The Mont-Megantic
Dark Sky Park

Best: Full Cut Off (FCO) Fixtures

- ▶ “Shoebox” design.
- ▶ Why do you think they are chosen?
...
- ▶ ... Appearance in the daytime!
- ▶ At night ...



Better for the sky

- ▶ Still some Glare though



"Vision" of Nocturnal Animals



•From www.urbanwildlands.org



- More light gathering capability due to larger eye, lens, pupil.
- Larger and more sensitive detector (i.e. retina) composed mostly of rods instead of cones – B&W vision.
- Three or more rods are connected by a neuron while each cone is connected by a neuron. Thus, the nocturnal animal's chance of seeing prey at night is greater, but the object is fuzzy.

- Enhanced hearing, even as advanced as echolocation in bats.



•Devil's Sinkhole near Rocksprings, TX

- Thick reflective membrane behind the retina, "tapetum lucidum," reflects light that missed the rods back to the rods for a second chance at detection.



Light Pollution and Plants

- ▶ Scientific studies are scarce on plants' departure from the norm when exposed to artificial light.
 - Lacking are studies on the effect of light levels.
 - The light environment provides one of the strongest abiotic signals to plants, there are four photoreceptor families.
 - Some plants have up to nine different photoreceptors.
- ▶ Many antidotal observations:
 - Branches of sycamores near street lights keep their leaves into late fall and winter (effect of street lights is highly localized and long-term consequences of response is unknown.)
 - Plane trees (sycamore) exposed to HPS lighting exhibited rapid and late season growth, but then suffered severe winter dieback compared with trees screened from lighting.
 - Soybean plants as far as 100 ft from prison security lighting are prevented from developing normally.
 - Cocklebur which are highly sensitive to light conditions still flower on schedule even along busy highways where car lights illuminate them.
 - Deciduous plants (shed leaves as days grow short in the fall) are thought to be most susceptible to artificial light.



Light Pollution may interfere with mating activity among nocturnal species



- ▶ Female Tungara frogs are more likely to choose a mate and be more discriminating in choosing a mate under dark conditions.
- ▶ The behavior change under lighter conditions: the frogs may perceive the threat that visually-oriented predators can now see them:
 - Resulting in a hasty selection of a mate.
- ▶ Fewer nesting locations are available in bright light conditions as female frogs search out locations shielded by brush.



- From Ecological Consequences of
- Artificial Night Lighting

Light Pollution can delay nightly feeding excursions of nocturnal animals (red-backed salamander)

- ▶ Study used white lights to brighten select locations of the salamander habitat to a level slightly less than natural twilight, but more than the full moon.
- ▶ During the first two hours of nightfall, more salamanders were found actively foraging for insects in the darker areas.
- ▶ The activity difference disappeared later in the night.

Implications of study:

- ▶ Artificial lighting has the potential to shorten foraging periods, thus limiting food intake.
 - ▶ This can lead to stunted growth and depressed reproduction and survival.
 - ▶ Decades-old research shows that amphibians calibrate their activity to the moon's cycles with least activity associated when the moon is brightest near full moon.
 - ▶ Since sky glow from light-polluted sites outshines the moon for nearly half of each month, it can extend the influence on reduced amphibian activity to longer than the full moon.
- Study by Buchanan and Wise, Utica College in New York



Migrating birds navigating by starlight can be lead astray by lights

- ▶ Migrating birds fly towards artificial lights at night and tend to circle the lights once encountered.
- ▶ Steady red lights on towers more attractive than white lights. Flashing lights less attractive.
- ▶ October 7, 1954 - 50,000 birds killed by flying into the ground following a beam from a guide light at Warner Robins A.F.B.
- ▶ On a rainy, foggy night in 1981, 10,000 birds collided with the floodlit smokestacks at Ontario's Hydro Lennox Generating Station.

- Partial Solutions:

- Fully shielded lights should be used to mitigate skyglow and glare.
- Fatal Light Awareness Program (FLAP) to turn off building architectural lights at night during migration season and nights with poor visibility.
- Top down lighting of billboards.
- Use flashing lights instead of flood lights on smoke stacks.
- Eliminate installation of unnecessary lighting.

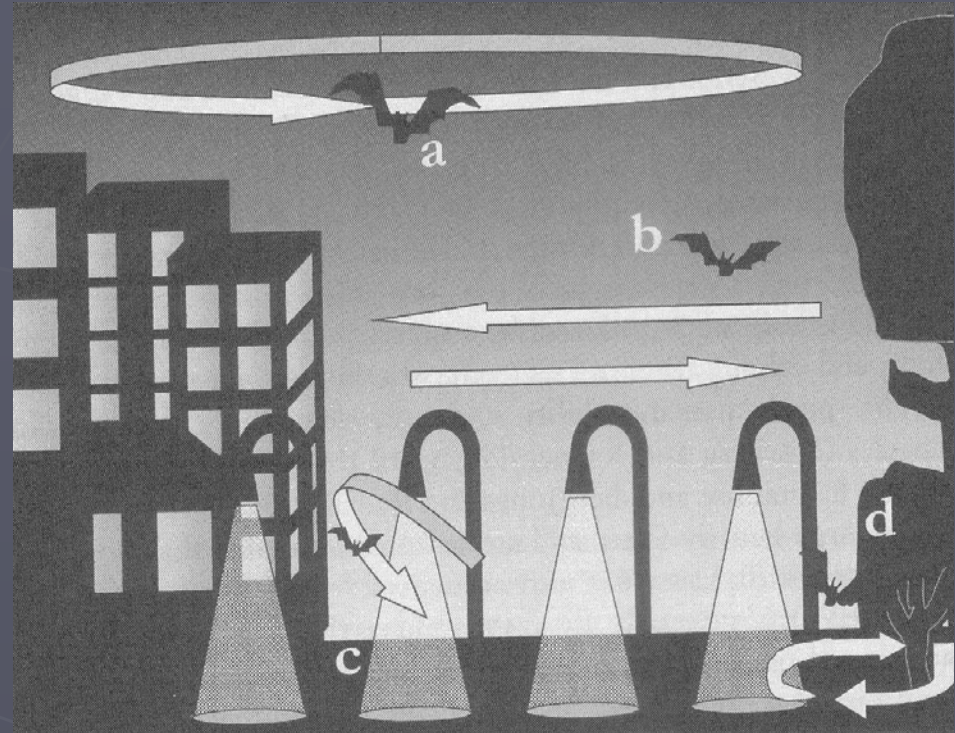


•from Clarke (1912)

- Urban Bird Treaty (2000) between the City of Chicago and US Fish & Wildlife asks that office and tenant buildings turn lights off during the spring and fall migrations.

Light Pollution affects both Bats and Insects

- ▶ Insects are drawn to streetlights providing a good and predictable food source for bats. HPS lamps attracts fewer insects than Mercury Vapor and other white lights.
- ▶ Bats will congregate around streetlights according to their size, speed, maneuverability.
- ▶ Moths will generally drop their defense mechanisms including evasive maneuvers, cessation of flight, and ultrasonic warnings while around a light (presumably thinking it is daytime and a bat source of ultrasound is unlikely).
- ▶ Not all bats (e.g. European lesser horseshoe bat) will utilize the food source around lights and stick with the more lean natural dark environment and can be displaced by bats that do exploit street lights.
- ▶ No study exists on how bat predation at streetlights affect the sizes of moth populations.



•From Ecological Consequences of Artificial Night Lighting

Where does the sky glow come from?

- ▶ Poor fixture design
- ▶ Lack of shielding
- ▶ Overlighting
- ▶ Poor installation
- ▶ Market Pressure

